

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 29 January 2001 (29.01.01)	
International application No. PCT/GB00/01998	Applicant's or agent's file reference XA1229
International filing date (day/month/year) 25 May 2000 (25.05.00)	Priority date (day/month/year) 05 June 1999 (05.06.99)
Applicant TIGHE, David, John et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

16 December 2000 (16.12.00)

☐ in a notice effecting later election filed with the International Bureau on:

RECEIVED

FEB 27 2001

TO 3600 MAIL ROOM

2. The election ☒ was .
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Pascal Piriou Telephone No.: (41-22) 338.83.38
------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 09 AUG 2001
PCT

Applicant's or agent's file reference XA1229	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/01998	International filing date (day/month/year) 25/05/2000	Priority date (day/month/year) 05/06/1999
International Patent Classification (IPC) or national classification and IPC B64C17/10		
Applicant BAE SYSTEMS PLC et al.		

RECEIVED
NOV 06 2001
GROUP 3600

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 16/12/2000	Date of completion of this report 07.08.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Alfaro Martinez, J Telephone No. +49 89 2399 7337



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01998

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-8 as originally filed

Drawings, sheets:

1/1 as originally filed

RECEIVED
NOV 06 2001
GROUP 3600

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01998

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-8
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-8
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-8
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document:

D1: US-A-5 321 945 (BELL DOUGLAS A) 21 June 1994 (1994-06-21)

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and refers to a fuel transfer apparatus for an aircraft comprising:
two or more fuel tanks arranged in an inboard to outboard alignment, at least one being situated in a wing of the aircraft, means for transferring fuel between the tanks, and a fuel management system for controlling and monitoring the transfer of fuel between tanks; wherein the fuel management system comprises means for receiving input signals.

The subject-matter of claim 1 therefore differs from this known D1 in that it comprises:
means for receiving a first input signal that the aircraft has left the ground,
means for receiving a second input signal that the aircraft is approaching its destination,
means for initiating the transfer of the fuel from a relatively inboard tank location to a relatively outboard tank location in response to the first input signal, and
means for initiating the transfer of the fuel from a relatively outboard tank location to a relatively inboard tank location in response to the second input signal.

The features of claim 1 allow actively controlling the distribution of the fuel between the available tanks during the whole of the ground-air ground cycle, thereby reducing the long term fatigue effect of the cyclic loading on the wings without the need to compensate by strengthening and reinforcing the wing structure with additional materials.

Since the combination of features contained in the independent claim is neither known from nor rendered obvious by the cited prior art, the subject-matter of claim 1, insofar as this claim can be understood (see Section VIII), meets the requirements of Article 33 (2) and (3) PCT.

Claims 2 to 8, dependent on claim 1, insofar as they can be understood (see Section VIII), thus also meet the requirements of Art. 33(2) and 33(3) of PCT.

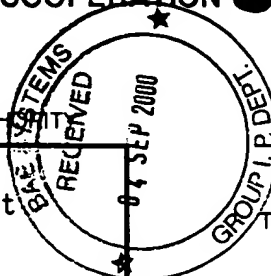
The industrial applicability of claims 1-8 is apparent and thereby satisfies Art. 33(4).

Re Item VIII

Certain observations on the international application

The claimed entity in claim 1 is "a fuel transfer apparatus", and the statement "for an aircraft" appears to indicate a particular use for which the product is suitable, thus not being part of the subject-matter of claim 1 (Guidelines, PCT Section IV, Chapter III, 4.8.a). However, further on this apparatus is defined by means of features of the aircraft ("...situated in a wing of the aircraft", "... input signal that the aircraft...", and implicitly "inboard to outboard alignment") to such an extent that it becomes unclear whether claim 1 is in fact directed only to the fuel transfer apparatus, or to the combination of an aircraft comprising a fuel transfer apparatus. Therefore, claim 1 is not clear (Article 6 PCT).

PATENT COOPERATION TREATY



From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
BAE SYSTEMS Group IP Departement
 Attn. EDIS, R.
 Lancaster House P.O. Box 87
 Farnborough Aerospace Centre
 Farnborough, Hampshire GU14 6YU
 UNITED KINGDOM

NOTIFICATION OF TRANSMITTAL OF
 THE INTERNATIONAL SEARCH REPORT
 OR THE DECLARATION

(PCT Rule 44.1)

11/21/02
4/11/00

Date of mailing (day/month/year) 04/09/2000	
Applicant's or agent's file reference XA1229	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/GB 00/01998	International filing date (day/month/year) 25/05/2000
Applicant BAE SYSTEMS PLC et al.	

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
 The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
 34, chemin des Colombettes
 1211 Geneva 20, Switzerland
 Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl. Fax: (+31-70) 340-3016	Authorized officer Gabriele Jülich
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.



REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) XA1229

Box No. I TITLE OF INVENTION AIRCRAFT STRUCTURE FATIGUE ALLEVIATION	
Box No. II APPLICANT	
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i> BAE SYSTEMS plc WARWICK HOUSE, P O BOX 87 FARNBOROUGH AEROSPACE CENTRE FARNBOROUGH HAMPSHIRE GU14 6YU, UNITED KINGDOM	
<input type="checkbox"/> This person is also inventor.	
Telephone No. 01252 384628	
Facsimile No. 01252 383091	
Teleprinter No.	
State (that is, country) of nationality: GB	State (that is, country) of residence: GB
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)	
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i> TIGHE, David John 6 Rushmoor Lane Backwell Bristol, Avon BS48 3BN, United Kingdom	
This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i>	
State (that is, country) of nationality: GB	State (that is, country) of residence: GB
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
<input checked="" type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.	
Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE	
The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: <input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative	
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)</i> EDIS, Ronald Malcolm BAE SYSTEMS GROUP IP DEPARTMENT LANCASTER HOUSE, P O BOX 87 FARNBOROUGH AEROSPACE CENTRE FARNBOROUGH, HAMPSHIRE, GU14 6YU, United Kingdom	
Telephone No. 01252 383430	
Facsimile No. 01252 383091	
Teleprinter No.	
<input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.	

Continuation of Box No. **FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)***If none of the following sub-boxes is used, this sheet should not be included in the request.*

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

WILLIAMS, Andrew David
135 Wheatfield Drive
Bradley Stoke
Bristol, Avon
BS32 9DB, United Kingdom

This person is:

- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:
GB

State (that is, country) of residence:
GB

This person is applicant
for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant
for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant
for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant
for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGN STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> LR Liberia |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MA Morocco |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BR Brazil | |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> TZ United Republic of Tanzania |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> IN India | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> IS Iceland | |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> ZA South Africa |
| | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> KR Republic of Korea | Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet: |
| <input checked="" type="checkbox"/> KZ Kazakhstan | <input checked="" type="checkbox"/> AG Antigua and Barbuda |
| <input checked="" type="checkbox"/> LC Saint Lucia | <input checked="" type="checkbox"/> DZ Algeria |
| <input checked="" type="checkbox"/> LK Sri Lanka | X MZ Mozambique |

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

Box No. VI PRIOR APPLICATIONS		<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1) 05 June 1999	9913032.0	GB		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)

* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA)
(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA / EP

Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):

Date (day/month/year)

Number

Country (or regional Office)

02 November 1999

99201829.1

EP

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following number of sheets:

request : 4

description (excluding sequence listing part) : 6

claims : 2

abstract : 1

drawings : 1

sequence listing part of description : -

Total number of sheets : 14

This international application is accompanied by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney, reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other (specify): GB Form 23/77 Request Certified Copy

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: ENGLISH

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).


Roland Malcolm EDIS

For receiving Office use only

1. Date of actual receipt of the purported international application:	2. Drawings: <input type="checkbox"/> received: <input type="checkbox"/> not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent): ISA /	
6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.	

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference XA1229	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/ 01998	International filing date (day/month/year) 25/05/2000	(Earliest) Priority Date (day/month/year) 05/06/1999
Applicant BAE SYSTEMS PLC et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ None of the figures.

RECEIVED
JUN 27 2000
PCT MAIL ROOM

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/01998

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B64C17/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B64C B64D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 321 945 A (BELL DOUGLAS A) 21 June 1994 (1994-06-21) abstract figure 2 column 1, line 8 - line 33 column 1, line 54 - line 59 column 2, line 26 - line 65 column 4, line 36 - line 59 ----	1-8
A	US 5 890 675 A (MARTINAGE THIERRY ET AL) 6 April 1999 (1999-04-06) abstract figure 6 column 2, line 7 - line 20 column 2, line 64 -column 3, line 4 column 7, line 17 - line 30 -----	1,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

28 August 2000

Date of mailing of the international search report

04/09/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Calvo de Nõ, R

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01998

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5321945 A	21-06-1994	NONE	
US 5890675 A	06-04-1999	FR 2747364 A	17-10-1997

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
14 December 2000 (14.12.2000)

PCT

(10) International Publication Number
WO 00/75013 A1

(51) International Patent Classification⁷: **B64C 17/10**

(21) International Application Number: PCT/GB00/01998

(22) International Filing Date: 25 May 2000 (25.05.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9913032.0 5 June 1999 (05.06.1999) GB

(71) Applicant (for all designated States except US): **BAE SYSTEMS PLC** [GB/GB]; Warwick House, P.O. Box 87, Farnborough Aerospace Centre, Farnborough, Hampshire GU14 6YU (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **TIGHE, David, John** [GB/GB]; 6 Rushmoor Lane, Backwell, Bristol,

Avon BS48 3BN (GB). **WILLIAMS, Andrew, David** [GB/GB]; 135 Wheatfield Drive, Bradley Stoke, Bristol, Avon BS32 9DB (GB).

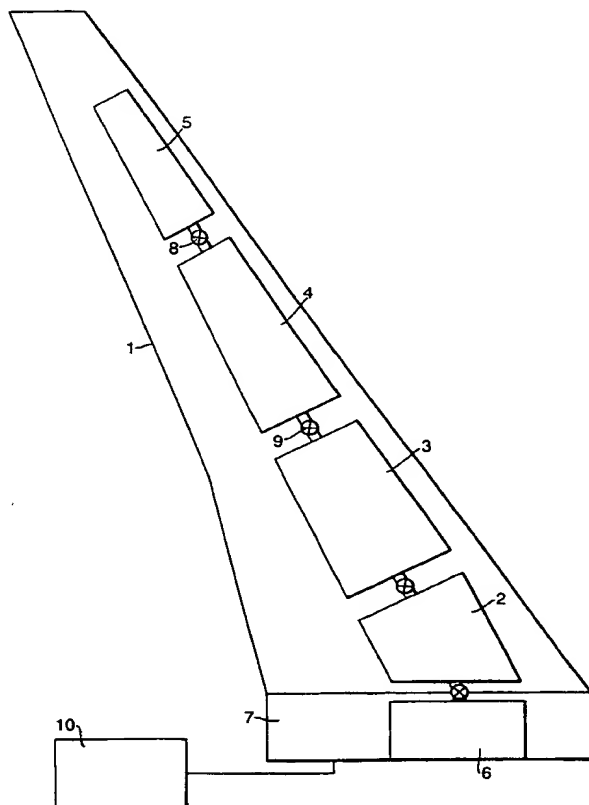
(74) Agent: **EDIS, Ronald, Malcolm**; BAE Systems, Group IP Dept., Farnborough Aerospace Centre, Lancaster House, P.O. Box 87, Farnborough, Hampshire GU14 6YU (GB).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

[Continued on next page]

(54) Title: **AIRCRAFT STRUCTURE FATIGUE ALLEVIATION**



(57) Abstract: A fuel transfer apparatus for an aircraft comprises: two or more fuel tanks (2, 3, 4, 5, 6) arranged in an inboard to outboard alignment, at least one being situated in the wing (1) of the aircraft, means for transferring fuel between the tanks (8, 9), and a fuel management system (10) for controlling and monitoring the transfer of fuel between tanks; the fuel management system comprises: means for receiving a first input signal that the aircraft has left the ground, means for receiving a second input signal that the aircraft is approaching its destination, means for initiating the transfer of the fuel from a relatively inboard tank location to a relatively outboard tank location in response to the first input signal, and means for initiating the transfer of the fuel from a relatively outboard tank location to a relatively inboard tank location in response to the second input signal.

RECEIVED

FEB 01 2001

TO 3500 MAIL ROOM

WO 00/75013 A1

WO 00/75013 A1



IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *With international search report.*

AIRCRAFT STRUCTURE FATIGUE ALLEVIATION

This invention relates to fatigue alleviation in aircraft during all phases of the ground-air-ground cycle (GAG).

Due to an increased demand for international air travel and in air traffic generally, there is a recognised need to increase the size and efficiency of both passenger and transporter aircraft. Customers also desire the capability to fly long distances at economical cost. As well as the physical size of the aircraft itself, the engineer has to consider the additional passenger and/or cargo weight to be carried by the craft and the quantity of fuel necessary to take the loaded craft safely to its destination.

A limiting factor in the design of such aircraft is the strength of the materials used, including those of the wing. For all commercial aircraft there are two fundamental design drivers which have to be met. Firstly there are the ultimate load cases; a once-only application of extremely high loading applied during abnormal conditions. There are a large number of these possible conditions and the aircraft is designed to withstand any which are foreseeable and then continue in safe flight and land safely. The aircraft may then be scrapped or require major repair. Secondly during all stages of the ground-air-ground (GAG) cycle, the wing is subjected cyclic loading conditions which cumulatively, over time, lead to the formation and then propagation of micro cracks and may ultimately appear as detectable cracks which require repair or maintenance to the aircraft. During cruise, the wings support the weight of the aircraft and bend upwards, whilst on the ground the wings are supported by the landing gear and possibly fuselage and thus bend downwards. The wings have to be designed to tolerate the damage caused by this cyclic loading to ensure structural integrity for the life of the aircraft. Today's technology allows accurate analysis of the large number of load cases that constitute the ultimate conditions; this allows the conservatism of yesterday's designs to be reduced, leading to more economic aircraft to operate. The effect of this is that modern aircraft are increasingly defined by the cyclic loading conditions so it is

- 2 -

evermore important to find ways to reduce the loading due to the GAG cycle. One approach is to find new ways of using the fuel weight to greater benefit.

Typically large aircraft are equipped with a number of fuel tanks positioned in their wings, the fuselage and tail area. Engine feed tanks are positioned near to the engines ensure a continuous supply of fuel to those engines, other tanks acts as reserves, storing fuel for transfer to the feed tanks as the feed tank supplies are burned. During flight, as the engine feed tanks begin to empty, a control system detects the reduction in fuel level and, once a predetermined level is recorded, causes fuel from the reserve tanks to be transferred to the feed tanks so that there is no interruption in the fuel supply to the engines.

The tankage is the total fuel capacity of the aircraft that is required for the aircraft to achieve its maximum payload range. However a typical flight is much shorter than the maximum so the available fuel tanks are not all filled. This allows a degree of flexibility regarding the positioning of fuel during the flight.

Conventionally, prior to take off, the outermost wing tank is full in anticipation of providing maximum wing bending relief once the aircraft has lifted-off. Unfortunately this also maximises damage to the wing during pre-flight taxiing and the take-off run. This invention seeks to alleviate this problem.

The present invention seeks to alleviate these problems and provide improved fatigue alleviation during the GAG cycle.

In accordance with the present invention there is provided a fuel transfer apparatus for an aircraft comprising:

two or more fuel tanks arranged in an inboard to outboard alignment, at least one being situated in the wing of the aircraft,

means for transferring fuel between the tanks, and

a fuel management system for controlling and monitoring the transfer of fuel between tanks

wherein the fuel management system comprises;

- 3 -

means for receiving a first input signal that the aircraft has left the ground,

means for receiving a second input signal that the aircraft is approaching its destination,

means for initiating the transfer of the fuel from a relatively inboard tank location to a relatively outboard tank location in response to the first input signal, and

means for initiating the transfer of the fuel from the relatively outboard tank location to a relatively inboard tank location in response to the second input signal.

This invention takes advantage of the fact that the aircraft is rarely fuelled for its maximum range to reduce the loading on the wing and centre section and hence their structure weight during the GAG cycle.

For a typical flight (which is likely to be only half the maximum range) the wing tanks will be filled from the root. This minimises wing damage during taxiing and the take-off run. Immediately the aircraft is airborne fuel will be then pumped outboard in the wing until it is as far outboard as possible leaving just the minimum fuel in the engine feed tanks. These feed tanks are continuously replenished during flight. As with current aircraft the outermost wing tanks will be emptied during descent, such that on landing these tanks are empty.

The optimum position for the fuel centre of gravity in an aircraft varies during the GAG cycle. During cruise, it is desirable to have the fuel centre of gravity as far outboard as possible to maximise wing bending relief for upward bending. At take-off and landing it is beneficial to have the fuel centre of gravity as far inboard as possible to minimise wing downward bending. Commonly, long range aircraft are operated below their maximum range capacity and therefore do not require all fuel tanks to be full at take off. This invention uses this fact to the advantage of the aircraft operator to minimise the effects of dynamic, cyclic loading caused by repeated GAG operation, consequently minimising downtime and maintenance costs and thus providing for more economical operation of the aircraft over a period of time.

- 4 -

By actively controlling the distribution of the fuel between the available tanks during the whole of the GAG cycle, the long term fatigue effect of the cyclic loading on the wings can be significantly reduced without the need to compensate by strengthening and reinforcing the wing structure with additional materials.

Benefits of this apparatus are particularly apparent in large, long range aircraft where wing structure weight savings of up to a tonne can be achieved providing a take-off weight saving of up to 2 tonnes per aircraft. It can be appreciated that by incorporating this apparatus, significant cost savings can be made both in manufacturing and operating costs for such aircraft.

In addition, less fuel may be needed for a given flight distance, reducing environmental pollution caused by bi-products of spent fuel.

Desirably the fuel management system is computerised and comprises a computer algorithm designed to respond to the various input signals and initiate the fuel transfer in the desired sequence. Optionally the computer algorithm can be specific to a particular flight path. A fuel management system may comprise a computer program which provides the flight crew with optional fuel management algorithms based on factors such as the flight path to be taken, the number of passengers and/or quantity of cargo to be carried, the overall quantity of fuel taken on board prior to departure, weather conditions, etc.

Conveniently, as means for responding to the first signal, the fuel management system can be programmed to respond to the signal conventionally sent to the flight control system of an aircraft when the gear wheels have left the ground to initiate retraction.

The fuel management system can be further programmed to respond to a second input signal that the aircraft has descended to a certain altitude on its approach to land. Alternatively a signal may be relayed between the flight control program and the fuel management system when a certain point on a pre-programmed flight path has been reached.

- 5 -

Desirably, the fuel management system will have manual override facility to enable flight crew to adapt to unforeseen circumstances.

Optionally during flight, the fuel management system may be programmed to transfer fuel between tanks in response to various stimuli, for instance a signal may be transmitted to the fuel management system to indicate increased or decreased activity of individual engines. As an additional safety feature, the fuel management system could be made to respond to detection of a leak in a particular tank, or unfavourable ambient conditions such as extremes of temperature which may affect the fuels properties.

The invention is further described, by way of example only, with reference to the drawing which illustrates a sample fuel tank layout for a large, long range passenger aircraft.

The drawing shows the distribution of tanks between the fuselage and one wing of an aircraft, the reader will appreciate that the principle can be extended to the second wing of the aircraft and that more or fewer tanks may be used, taking account of the size and fuel requirements of the aircraft in question. The wing (1) comprises 4 fuel tanks, an inner engine feed tank (2), an inner transfer tank (3), an outer engine feed tank (4) and an outer transfer tank (5). A further fuel tank, the centre tank (6) is located in the fuselage (7). Each of the tanks is connected to a fuel line (8) in which, between it and each tank, is located a two way valve (9). The fuel management system not shown co-ordinates the following fuel transfer operation during the GAG cycle.

Prior to taxi and in the run up to take off, each of the engine feed tanks (2, 4) retains a minimum safe level of fuel sufficient to operate the engines (not shown). Depending on the volume of fuel carried, the remaining fuel is pumped by the fuel management system into the centre tank (6) until this tank reaches its maximum capacity, remaining fuel is pumped to the inner feed tank (2) if that becomes full, the remainder is then pumped into the inner transfer tank (3) until that is full, and so on. Thus the fuel centre of gravity is retained as far inboard of the aircraft as possible.

- 6 -

On take-off, the wheels of the aircraft are retracted into the body of the plane. As the wheel retraction process begins, a signal is sent to the fuel management system which then initiates transfer of fuel between the tanks as follows:

Again a minimum safe level of fuel sufficient to operate the engines is retained in the engine feed tanks (2, 4). Fuel from the most inboard tanks (6, 2, 3) is carried through the fuel line (9) and transferred to the outer transfer tank (5) until it reaches its maximum capacity. Remaining fuel is transferred to the outer engine feed tank (4) until that tank reaches its maximum capacity. Any further remaining fuel is transferred or retained in the inner feed tank (2) and so on. Thus the fuel centre of gravity is repositioned to be as far outboard of the plane as possible.

During the flight, the fuel management system continuously feeds the engine feed tanks from the most inboard source to maintain a relatively outboard position of the fuel centre of gravity. As the aircraft approaches its destination and begins its descent towards the landing field, a signal is sent to the fuel management system which initiates a re-transfer of the remaining fuel back towards the centre tank (6) in the fuselage and the inner most wing tanks (2, 3).

The skilled reader will appreciate that it is not essential that any fuel be carried in or transferred to the fuselage or tail area of an aircraft and that the invention can be effectively applied to aircraft where all fuel storage is provided along the length of the wings.

- 7 -
CLAIMS

1. A fuel transfer apparatus for an aircraft comprising:

two or more fuel tanks (2,3,4,5,6) arranged in an inboard to outboard alignment, at least one being situated in a wing (1) of the aircraft,
means for transferring fuel between the tanks (8, 9), and
a fuel management system (10) for controlling and monitoring the transfer of fuel between tanks

wherein the fuel management system comprises;

means for receiving a first input signal that the aircraft has left the ground,

means for receiving a second input signal that the aircraft is approaching its destination,

means for initiating the transfer of the fuel from a relatively inboard tank location to a relatively outboard tank location in response to the first input signal, and

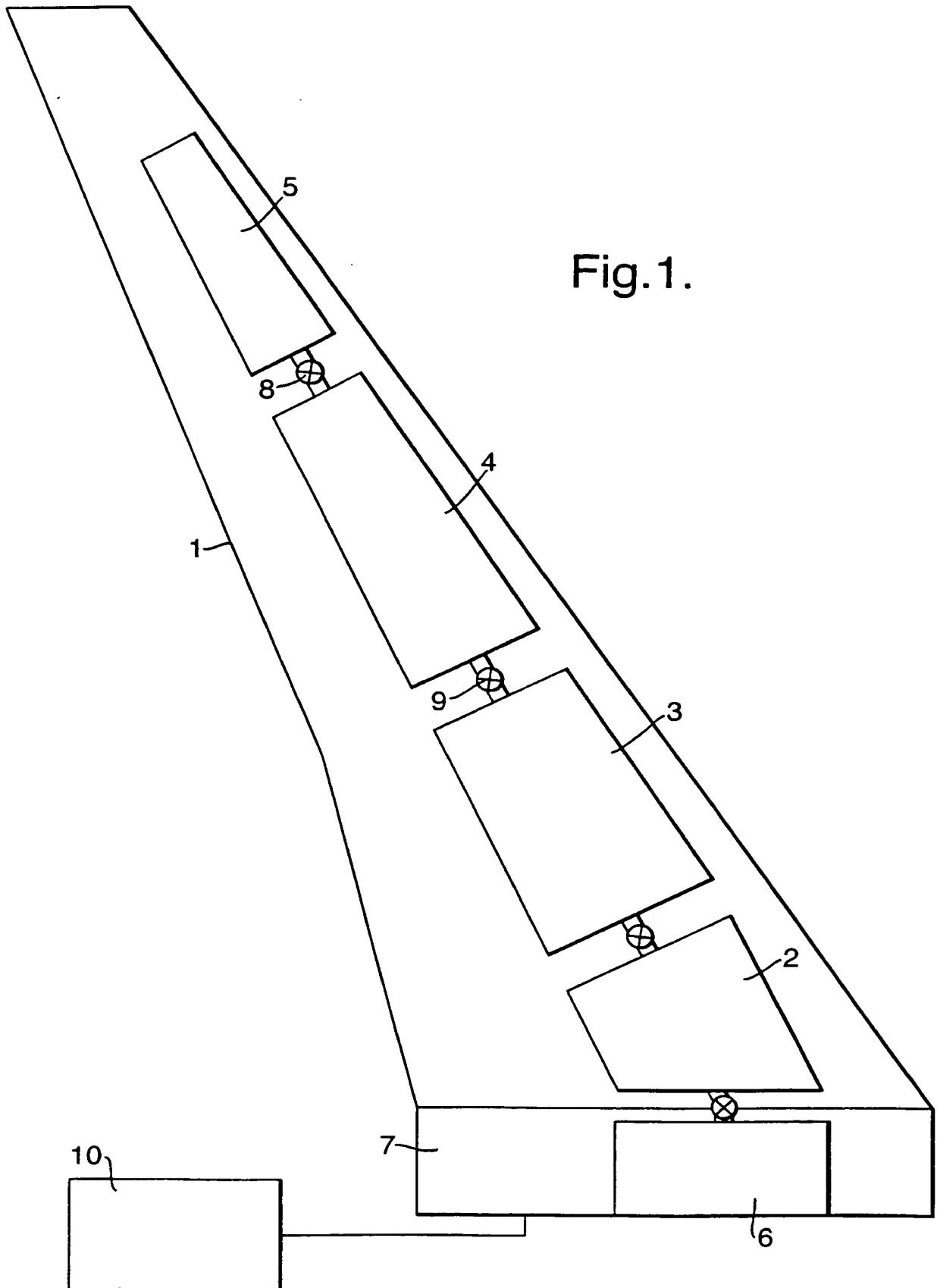
means for initiating the transfer of the fuel from a relatively outboard tank location to a relatively inboard tank location in response to the second input signal.

2. A fuel transfer apparatus as claimed in claim 1 wherein the fuel management system (10) is computerised and comprises a computer algorithm designed to respond to the various input signals and initiate the fuel transfer in the desired sequence.
3. A fuel transfer apparatus as claimed in claim 2 wherein the computer algorithm is specific to a pre-programmed flight path for the aircraft.
4. A fuel transfer apparatus as claimed in any preceding claim wherein the fuel management system (10) is programmed to respond to a first signal sent to the flight control system of the aircraft when the gear wheels have left the ground.

- 8 -

5. A fuel transfer apparatus as claimed in any preceding claim wherein the fuel management system (10) is programmed to respond to a second input signal that the aircraft has descended to a certain altitude on its approach to land.
6. A fuel transfer apparatus as claimed in any of claims 1 to 4 wherein a second input signal is relayed between the flight control program and the fuel management system (10) when a certain point on a pre-programmed flight path has been reached.
7. A fuel transfer apparatus as claimed in any preceding claim wherein the fuel management system (10) will have manual override facility to enable flight crew to adapt to unforeseen circumstances.
8. An aircraft comprising a fuel transfer apparatus as claimed in any one of the preceding claims.

Fig.1.



INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/01998

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B64C17/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B64C B64D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 321 945 A (BELL DOUGLAS A) 21 June 1994 (1994-06-21) abstract figure 2 column 1, line 8 - line 33 column 1, line 54 - line 59 column 2, line 26 - line 65 column 4, line 36 - line 59 ----	1-8
A	US 5 890 675 A (MARTINAGE THIERRY ET AL) 6 April 1999 (1999-04-06) abstract figure 6 column 2, line 7 - line 20 column 2, line 64 - column 3, line 4 column 7, line 17 - line 30 -----	1,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

28 August 2000

Date of mailing of the international search report

04/09/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Calvo de Nõ, R

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01998

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5321945	A	21-06-1994	NONE	
US 5890675	A	06-04-1999	FR 2747364 A	17-10-1997

RECEIVED

FEB 01 2001

TO 3600 MAIL ROOM